ALBERTA FOREST GENETIC RESOURCES COUNCIL

2002-03 ANNUAL REPORT

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members
Alberta Forest Genetic Resources Council

Scientific Sector	Dr. John Spence, Dr. Bruce Dancik, Dr. Ken Mallett
Biological Sector:	Dr. Chris Shank
Industry Sector:	Mr. Robert Udell, Dr. Sally John, Mr. J.P. Bielech, Dr. Barb Thomas, Mr. Bruce Macmillan
Government Sector:	Mr. Doug Sklar, Dr. Narinder Dhir, Mr. Neil Barker
Chair:	Mr. Cliff Smith

For further information, or to request additional copies of this report, please contact:

Phone: (780) 449-5626 Fax (780) 449-5626
Web Site: http://www3.gov.ab.ca/srd/forests/fmd/genetics/
E-mail: afgrc@shaw.ca

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message from the minister

I am pleased to release the Alberta Forest Genetic Resources Council (AFGRC) Annual Report for 2002-2003.

This past year marked a significant step forward for the Council with the development of the draft manual entitled *Standards for Tree Improvement in Alberta*. With final approval by the government early in the next fiscal year, there will be a formalized and organized framework available for the planting of improved native species and regular wild tree stock on Crown land. The manual will provide government and industrial forest managers with a vital tool for enhancing the sustainable management of Alberta's forest resources.

Looking forward, the AFGRC continues to examine the possibility of planting non-native species on Crown land. This emerging issue offers significant potential to improve productivity on the landscape and will be a valuable management tool for industry. The AFGRC is working to ensure questions and risk assessments relating to forest health, biodiversity and ecosystem integrity are addressed and completed prior to any decision on large-scale planting.

In keeping with its commitment to improve communications within the scientific community, AFGRC is seeking to strengthen ties with the Alberta Forest Research Institute. By forging a strong working relationship, the two bodies will be able to take advantage of the natural synergies created and promote a broader range of research projects.

I look forward to receiving continued advice from the AFGRC and wish them every success in the coming year.

M. Cardinal

Honorable Mike Cardinal
Minister of Sustainable Resource Development
MLA, Athabasca/Wabasca Constituency

message from the chair

The Alberta Forest Genetic Resources Council marked its third anniversary at the conclusion of the 2002-03 fiscal year, a year during which Council found itself immersed in a number of continuing policy initiatives and issues.

The completion of the Alberta Forest Genetic Framework was unquestionably the major highlight of the year. Many Council members were directly involved in its development. Throughout the process, Council provided support and recommendations to the various task groups charged with this major groundbreaking initiative. At the completion of the process, Council reviewed the final product and provided its endorsement and recommendations to the Government of Alberta for review by the Standing Policy Committee responsible for Energy and Sustainable Development. The final product, entitled *"Standards for Tree Improvement in Alberta,"* is scheduled for approval by the Alberta Cabinet early in the next fiscal year. Undoubtedly Council will continue its involvement in an advisory capacity as the framework's policies are implemented and as they continue to evolve through the years.

The debate over the ecological and biodiversity impacts of using non-native trees in reforestation continued to spark considerable interest and discussion at Council meetings throughout the year. A paper produced by the Alberta Research Council for the Department of Sustainable Resource Development provided the basis for discussion. The initial draft of the paper underwent substantive revision based in part on the suggestions of Council, and was undergoing a final peer review prior to Council resolving its final position with respect to the review, expected early in the next year.

AFGRC has taken a lead role in developing a national initiative for the benchmarking of Forest Genetic Resources programs. A recently-modified proposal has achieved support in principle by a number of jurisdictions and individuals across Canada. Work will continue on this exciting development.

Council continued to provide guidance on a number of standing policy reviews, including Council's position regarding the use of genetically modified organisms (GMOs) in forestry, conservation of Alberta's forest genetic resources, and the Alberta Forestry Research Institute. With regard to this latter initiative, the chair participated in two developmental workshops to help set the strategic direction for the new institute. These policies, because of their dynamic nature, will require regular and ongoing attention by Council.

The past year has been a most difficult one for the forest industry and for resource departments in governments, because of significant downturns in forest product markets, exacerbated by the softwood lumber trade dispute with the U.S. This situation underscores the need for rapidly-evolving tree improvement and genetic resource conservation programs that will help ensure the survival and prosperity of the forest sector. The Alberta Forest Genetic Resources Council has an important role to play in ensuring the delivery of these important programs.

Cliff Smith,
Chair, AFGRC

forest genetics in alberta

The forest genetics and tree improvement program in Alberta was started in 1975 by the provincial government in cooperation with the forest industry. This was done shortly after a forest genetics research and advanced studies program was established at the University of Alberta in 1974. Close cooperation and working relationships have existed between the two programs, which have complementary strengths and synergies.

Alberta's program is perhaps unique, as it was started at a time when the provincial forest harvest levels and annual reforestation programs were relatively small and surplus unallocated wood volumes were widely available throughout the province. The program was conceived as an investment for the future to develop and sustain a strong and vibrant forest products industry, which was expected to require increasing timber harvest from provincial Crown lands on a sustainable basis. The program required large initial investment in scientific infrastructure, manpower resources and operational needs. This was helped substantially by a grant from the Alberta Heritage Savings Trust Fund, which in the late 1970s supported projects with potential to strengthen and diversify the provincial economy into the renewable resources sector.

Now into its 27th year of operations, a strong and a very well developed program is in place. It is yielding an economic payoff through increased growth, timber quality and climatic/pest hardiness of the future forest. It is also making significant contributions to the conservation of heritage forest genetic resources, scientific research and environment protection. Throughout its development and brief history, the program has faced many challenges and has adapted to changing industrial and societal demands. These included shifting objectives from primarily growth-and-yield enhancement to integrated genetic resources management. The focus today is on forest health, genetic diversity, genetic gain and gene pool conservation issues. The background context is provided by government reducing its direct role in program development and delivery in favor of cooperative activity with industry and other scientific cooperators.

With the "domestication" of forestry and increasing deployment of newly-developed varieties of forest trees, new challenges have emerged. These relate to maintaining biodiversity, of which the fundamental building blocks are genes and genotypes, and safeguarding the health, productivity and evolutionary potential of future forests. These are being addressed largely through the leadership and policy direction provided by the Alberta Forest Genetic Resources Council and the newly established *Standards for Tree Improvement in Alberta*. Future challenges include strengthening scientific research and advanced education programs in Alberta and successful adaptation of Alberta forestry to global climate change. Alberta's forest genetics and tree improvement program is uniquely qualified to fulfill these needs.

tree improvement programs

Tree improvement in Alberta involves more than 20 active programs in eight native species, of which six are coniferous and two are deciduous. All programs are based on traditional plant breeding methods, and no genetic modification (GM) is involved. Most programs include genetic gain as a primary objective, although some are designed primarily to alleviate seed shortages. Conservation of genetic diversity and maintenance of adaptability to natural environments are two primary objectives of all programs. Several exotic species are under consideration, either as pure species or as parents in hybrid programs. While some companies have initiated independent programs, most programs are being developed through cooperative arrangements either among companies, or between Alberta Sustainable Resource Development, Land & Forest Division (ASRD) and single or multiple companies. Several programs are also being developed by ASRD alone.

The first coniferous programs were initiated in 1976 and new programs have been continuously added up to the present. The older programs are beginning to mature and some orchards have produced considerable amounts of seed for operational deployment. A broad genetic base has been accumulated and grafting in *ex situ* reserves has preserved thousands of wild genotypes. A system of *in situ* reserves is also being initiated for species involved in breeding programs.

Progeny tests associated with the older programs are yielding fast-growing healthy individuals for inclusion in the next generation's breeding populations.

Coniferous programs are summarized at right.

Programs for deciduous species were initiated more recently. Since the early 1990s, several private companies have been investigating and developing programs in aspen and aspen hybrids, balsam poplar, hybrid poplars, and birch. The focus for these programs has primarily been on adaptation and growth rate, as well as stock production and establishment. Deployment is planned on both private and public land.

The first aspen cooperative program was formally initiated in 1994 by a group of forest products companies. Since then, hundreds of genotypes have been selected and tests have been established on a number of sites. Hybrid breeding programs involve crossing the native *Populus tremuloides* with *P.tremula* from Europe and *P. davidiana* from eastern Asia. Research in silviculture, stock production and breeding techniques has proven essential for working with both aspens and poplars.

The provincial genetics policy *(Standards for Tree Improvement in Alberta,* May 1, 2003 – see page 3) is expected to encourage investment in tree improvement activities. The policy establishes a framework for program development and accrual of benefits, while ensuring that genetic diversity and conservation objectives are met.

	# of programs	parents in programs	parents under test	genotypes in orchards	trees in orchards	seed produced (kg)
Douglas-fir	1	40	0	35	120	0
Western larch	1	27	0	18	74	0
Jack pine	1	68	0	51	318	0
Lodgepole pine	7	1,912	1,633	520	7,943	111.3
Black spruce	3	234	179	266	3,501	0.1
White spruce	9	1,255	580	795	7,757	332.9
Total	**22**	**3,536**	**2,392**	**1,685**	**19,713**	**444.3**

• tree improvement standards

Standards for Tree Improvement in Alberta were released in manual form for implementation May 1, 2003. The manual provides standards which guide traditional reforestation activities, enable industry to plant genetically improved stock on Crown land and direct conservation efforts necessary to preserve the genetic diversity of Alberta's Crown forests.

Although not a direct Council initiative, these standards represent almost two years of exhaustive work by over 40 scientists and resource managers, some of them Council members, working within the Alberta Forest Genetics Framework. This framework process was directed by a primary task group, which delegated work to five technical groups charged with developing draft policy and solving technical problems. The draft standards were submitted to Council for review and input once they had been reviewed and consolidated by the primary group. Council endorsed the draft standards in September, 2002.

The draft standards were then submitted for review by stakeholders and affected government departments. Input was reviewed and adjustments made to the standards prior to submission to the Standing Policy Committee and Caucus for approval.

The standards manual consists of the following five sections:

1. **Ownership and Data Access** which provides principles for governing access to and ownership of genetic materials collected or deployed on Crown land and to their related information.
2. **Material Collection, Handling, Registration and Storage** which provides standards for handling of both wild and improved genetic materials from collection site to plantation.
3. **Green Area Deployment** which provides standards to be met in the deployment of reforestation material in order to manage the potential risks surrounding adaptation, diversity and estimating genetic gain.
4. **Breeding, Testing and Verification** which establishes the planning and procedural steps to be taken in establishing programs where selected parental material is to be established in facilities such as seed orchards and stool beds to produce reforestation materials.
5. **Production of Controlled Parentage Material** which sets standards for the establishment of production facilities producing reforestation materials as well as information and procedural requirements necessary to produce a crop that is eligible for registration and use on Crown land.

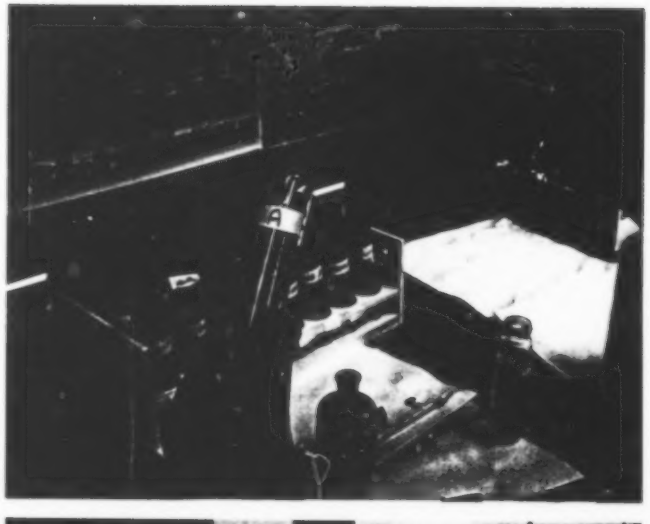
These standards are to be reviewed annually for the first two years and again after five years.

benchmarking forest genetic programs

The Alberta Forest Genetic Resources Council decided in April, 2000, to undertake a project on benchmarking of forest genetic resources programs in Alberta. The project is to provide objective quantification of how our programs are performing compared to similar programs in Canada. The idea was discussed with the other three similar Councils (British Columbia, Ontario and New Brunswick) and it was decided to modify the concept to a national survey involving all Provinces and Territories.

The survey will gather information on the status of various activities directly related to forest genetic resources management across Canada. Five categories related to forest genetics have been identified - native species, genetically modified organisms, non-native tree species, education in forest genetics and tree improvement, and forest genetic advisory Councils and Boards. Information on policy, practices and processes followed by different jurisdictions in Canada will be compiled and summarized with regard to key elements or "benchmarks" of forest genetic resources management. The survey results should provide a good understanding of similarities and differences between programs and provide an opportunity to learn from each other in making individual programs better, both technically and in their accountability to stakeholders.

The survey questionnaires have been sent to all Provinces and Territories except Nunavut, which does not have a forestry program. The results will be reported in next year's annual report of the Alberta Forest Genetic Resources Council, shared with interested parties and participants, and presented at the 2004 meeting of the Canadian Tree Improvement Association in Kelowna, B.C.



forest gene resources conservation

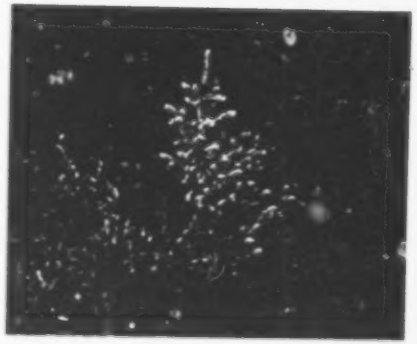
Forest Gene Resources Conservation Program work in Alberta in 2002 included the following:

- With a seed zone system implemented as part of the new *"Standards for Tree Improvement in Alberta,"* seed zones now provide ecologically based geographic units for forest tree conservation planning and activities in the province. Several new standards also clarify roles and responsibilities of the Crown and companies in conservation and provide some basic procedures and targets for conservation work.

- In November, 2002, a letter of agreement was signed between Land and Forest Division of Alberta Sustainable Resource Development and Parks and Protected Areas Division of Alberta Community Development. This agreement establishes the intent to engage in cooperative work on the conservation of heritage forest genetic resources in Alberta and the implementation of a provincial gene conservation plan for Alberta forest trees. Areas of cooperation include: the development of a list of provincial trees, a review of the status of provincial tree species and conservation priorities, development and update of information on the natural distribution of species, review of provincial Protected Areas to determine areas suitable to meet the needs for gene conservation, strategic seed and vegetative materials collections to complement *in situ* conservation and the implementation of management plans for areas chosen for gene conservation. An initial planning meeting was held in March, 2003.

- As part of the cooperative work being undertaken with Parks and Protected Areas, whitebark pine and limber pine have been identified as a priority for conservation efforts as they are on the Alberta Natural Heritage Information Centre's watch list. The threat to these two species of native soft pines arises from a limited distribution in Alberta as well as their susceptibility to white pine blister rust, an introduced fungal pathogen, and the expected vulnerability of their main seed dispersal agent, the Clark's nutcracker, to West Nile Disease. Damage to these two pines has been extensive in portions of their British Columbia and U.S. range and the disease has also been identified in Alberta. The magnitude of the threat is not fully known due in part to inadequate information on the abundance and distribution of these two non-commercial species as well as on the extent of infection. Several agencies including Forest Management Branch, Parks and Protected Areas, the Canadian Forest Service and Parks Canada are currently working on surveys to determine host ranges and abundance, and levels of infection. Once this information is available, the risk can be assessed and the appropriate conservation status determined and conservation activities planned.

- During the past year, Forest Management Branch has continued acquiring and compiling digital data as part of the requirement for implementing the gap analysis portion of the provincial tree gene resources conservation plan. These data include digital elevation models, forest inventories, satellite imagery, climatic models, species distributions and line work for protected areas, seed zones and Natural Subregions. Additional data is available from Parks and Protected Areas to assist in this process.



climate change and genetic resources

The relationship between climate and the distribution of plants and animals has been recognized for centuries. Most recently, concerns that climate is changing in ways that have significant impacts on the Earth have stimulated interest in the description and prediction of climate and of responses of plants and animals. To address that interest, Alberta Sustainable Resource Development and Alberta Environment have initiated a project involving four aspects of climate and its relationships with genetic variation in forest trees.

In a preliminary step to addressing questions of climatic change, an interdisciplinary group has expanded the database on Alberta climate. As in most jurisdictions, climatic stations in Alberta are concentrated in urban and agricultural areas with under-representation of forests and lightly settled areas. Stations in more remote areas often produce only partial records with seasonal gaps in data. By reducing the number of years of observations required for inclusion in a database, we have approximately tripled the number of geographic points for which consistent data are available in the national database. The data have been assembled in an archive containing observations for monthly mean daily temperature, monthly mean daily maximum temperature, monthly mean daily minimum temperature and monthly mean precipitation.

Using data from the archive, values for 16 variables expected to be important in the distribution and responses of trees to climate have been derived. Mean temperature of the coldest month, degree-days above 5°C. and annual moisture index are

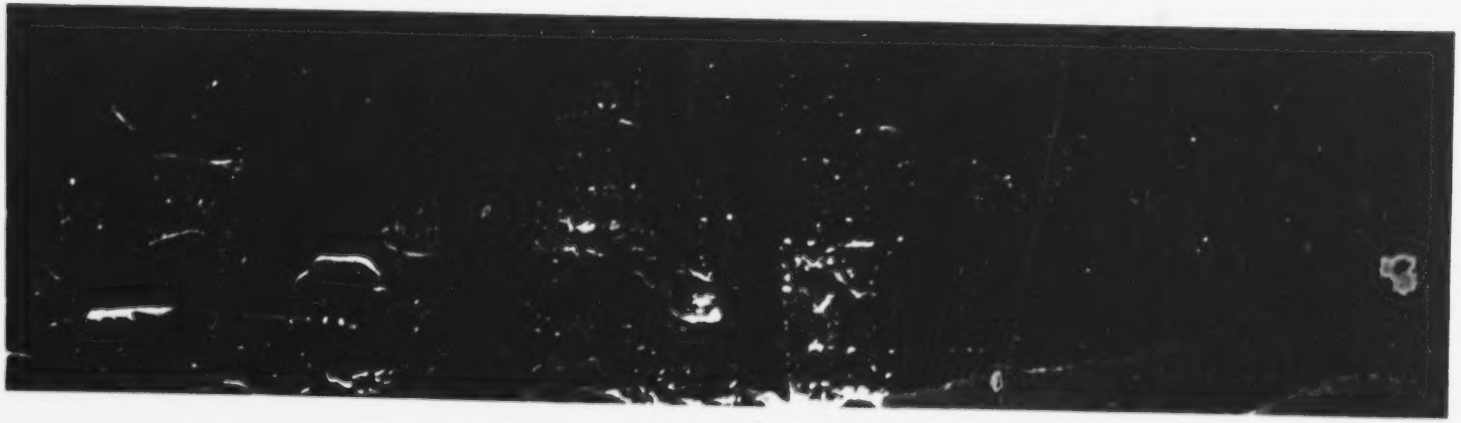
examples. These variables will be used in on-going research on climate/forest tree relationships.

In addition, using the modern mathematical technique known as thin-plate splining, the pattern of fixed-point climatic stations has been transformed into continuous surfaces that allow the estimation of climatic variables at any point in Alberta. This will be especially useful in addressing questions of climate/tree relationships at locations of experiments far removed from climatic stations. Splining also facilitates the production of maps to a resolution as small as one kilometre.

This project will now combine results from the Alberta Climate Prediction Model with projections from global climatic models to illustrate potential impacts of global warming on the climate of Alberta.

Also in progress is the exploration of mathematical descriptions expressing the relationships between genetic variation of tree species and climate. Elsewhere, studies of this type have shown very high degrees of fit for several climatic variables, especially those associated with timing and amount of growth.

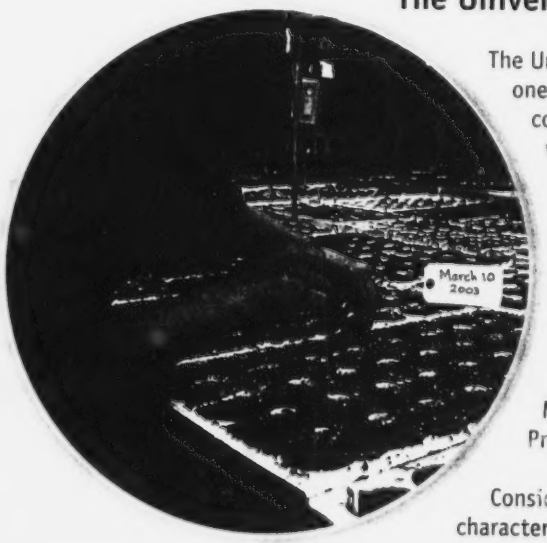
Assuming that the relationships between current climate and genetic response are similar in possible future climates, the impact of climate change on tree species of Alberta can be estimated. Moreover, the identification of areas where current climate is similar to areas of future climate may provide a basis for locating sources of genetic material that will be adapted to a changed climate. Such areas may warrant special consideration for gene conservation.



research and trials

Scientific research and experimental field trials continue to provide an expanding knowledge base for Alberta's many and diverse programs involving forest genetics, tree improvement, gene resources conservation and deployment of improved tree varieties in reforestation. This important work is delivered through Alberta's universities, the Canadian Forest Service, the forest industry and Alberta Sustainable Resource Development. A significant part of the work also involves collaboration with other scientific organizations at national and international levels, and regional partnerships with the provincial forest service and industry in the neighboring province of British Columbia.

The University of Alberta



The University of Alberta provides just one example of the innovative and collaborative research programs under way in the area of forest genetics. The research is conducted by several laboratories in the Department of Biological Sciences and the Department of Renewable Resources. The following notes deal only with work done in the Department of Renewable Resources by Professors Peter Blenis, Bruce Dancik, Ellen Macdonald and Francis Yeh, and Adjunct Professors Barb Thomas and Dick Pharis.

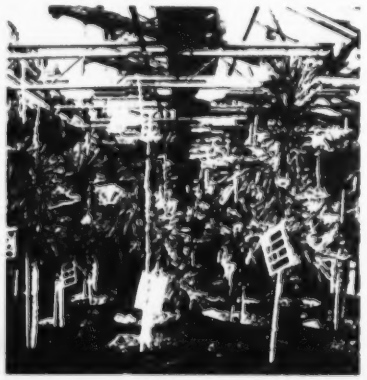
Considerable work deals with genetic characterization and use of trembling aspen and hybrid poplars for plantation forestry and reclamation with special emphasis on field performance, biomass production and carbon sequestration potential *(Dancik, Macdonald, Thomas)*. Results of ongoing work will help assess how the CO_2 level during greenhouse culture affects subsequent field performance for each of several genetic groups of aspen and for the hybrid poplars. Several projects about resistance to western gall rust, shepherd's crook and *Septoria* canker have been pursued with the aim of effectively deploying resistant individuals on forested landscapes (Blenis).

Other work with graduate students (the Yeh lab) focuses on tree improvement, evolution and gene conservation. Recently they have (1) developed an early genetic evaluation and selection strategy for Alberta white spruce using seedling traits and seasonal growth curves; (2) advanced host-pathogen co-evolution theory using lodgepole/jack pines and western gall rust as the model system; (3) explored how genetic variation is organized in lodgepole pine, constructed the first genomic map of Alberta lodgepole pine and mapped nine loci that confer major resistance to western gall rusts; (4) identified and isolated genes that confer salt tolerance in Alberta jack pine and black spruce; and (7) developed POPGENE, state of the art software that many geneticists worldwide use to analyze their population genetic data. Dancik continues work on the evolution of several putative hybrid complexes of woody plants as well, investigating the potential risks to hybridization between native and non-native poplars (with Thomas).

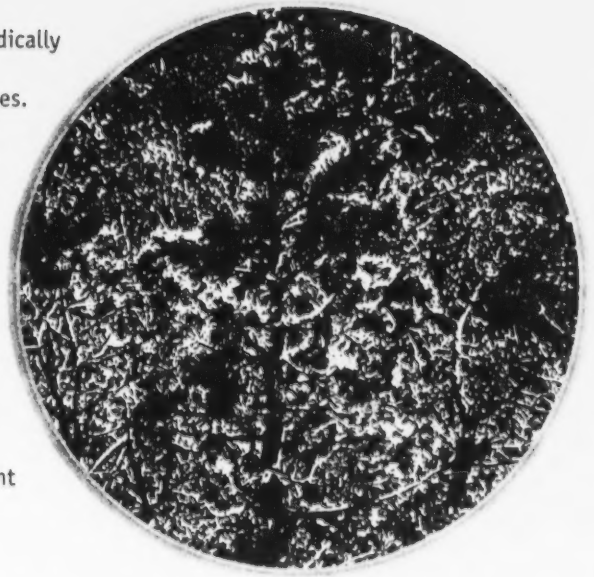
The work in Renewable Resources has involved partnerships with Alberta Oil Sands Technology and Research Authority (Alberta Energy), Alberta Sustainable Resource Development, Alberta-Pacific Forest Industries Inc. (Al-Pac), Daishowa-Marubeni International Inc. (DMI), Weyerhaeuser Company, Mobil Oil Canada, Suncor Energy Inc., and Syncrude Canada Ltd.

Alberta Tree Improvement and Seed Centre

The Alberta Tree Improvement and Seed Centre near Smoky Lake is operated by the Land and Forest Division of Alberta Sustainable Resource Development. The centre carries out applied research in support of the provincial forest genetic resources management program and practical tree breeding to enhance growth, yield, timber quality and climatic/pest hardiness of the future forest. The focus is on understanding and conserving genetic diversity of the major forest tree species of Alberta and developing knowledge on inheritance patterns and genetic relationships of important tree traits. Scientific knowledge is developed primarily through establishing long-term field experiments and their periodic measurements and analysis. Research studies have also been established on improving seed production and seed quality from seed orchards producing superior tree varieties for regional reforestation and environmental responses of genotypes and populations of forest tree species to study their adaptation to present and future climates.



The work is carried out cooperatively with forest industry, the Canadian Forest Service, provincial forest services and other scientific organizations. There is a well-established network of field experiments containing nearly 200 research studies located at 44 research installations throughout Alberta and at a few selected locations in northeastern British Columbia. The oldest field experiments are 27 years old. Results from the research studies are periodically summarized and made available to practitioners and scientific audiences. The research projects also provide scientific training and educational opportunities for post-graduate students working in the area of genetics and tree improvement, mainly at the University of Alberta. As well, the research supports development of scientific data and technical information regarding tree improvement standards and other regulatory needs in the area of forest genetic resources management by the provincial government.



Canadian Forest Service

Conservation requires an understanding of how natural agents can threaten certain populations. The Canadian Forest Service is contributing to this knowledge with a study of a disease that threatens limber pine and whitebark pine, which in Alberta are found only in the southwestern corner of the province within the foothills and Eastern Slopes of the Rocky Mountain Range.

White Pine Blister Rust (WPBR), *Cronartium ribicola*, is a non-native fungus, which infests, damages and kills soft pines, and is present throughout most of North America. This species has been present in Alberta for several decades and infests whitebark pine, *Pinus albicaulis*, and limber pine, *Pinus* ▶

flexilis. Neither of these pines are important commercial species but they have high conservation value. The Canadian Forest Service reports that while there have been several surveys of WPBR incidence and damage in whitebark pine, very little is known about the impact of the disease on limber pine. Anecdotal observations from 2002 indicate that WPBR infestation rates are extremely high throughout the southern Porcupine Hills in stands where the fungus was virtually absent in 1989 and earlier. Some data collected from limber pine in Alberta in 1996 showed 46 per cent mortality and 93 per cent infection in Waterton Lakes National Park and 14 per cent mortality and 76 per cent infection in the Porcupine Hills. As limber pine has a relatively small distribution in Canada, and the species is of high conservation value, surveys were initiated in 2003 by the Canadian Forest Service, in collaboration with Alberta Sustainable Resource Development (ASRD), to ascertain the extent and incidence of WPBR-caused mortality and damage in limber pine in Alberta. Research plots established as part of the 1996 work will be revisited to ascertain changes in damage levels since 1996. Initial data (as of early June) from a small number of sites in the Porcupine Hills indicate limber pine mortality (from all causes, but mostly due to WPBR) of about 50 per cent and infection rates in excess of 90 per cent. The extent of damage appears to be a cause for concern.

The surveys in 2003 will give a general overview of the extent and severity of the problem, which will help to focus additional work in subsequent years. Seed will be collected where available to aid *ex situ* conservation. WPBR spores have been collected for genetic fingerprinting. A survey of WPBR in whitebark pine is being coordinated by ASRD in 2003 using the same protocols developed for limber pine. Efforts by ASRD to map the distribution of limber pine and whitebark pine in Alberta will further assist survey efforts. It is expected that surveys will continue in 2004. Also, planning is underway to initiate research to assess the impacts of WPBR on genetic variation in limber pine and to look for potentially resistant genotypes.

Industry's Role

HASOC is a consortium of five companies in west-central Alberta with several operational trials underway at its seed orchard complex. The main focus of this research is on increasing seed production in mature white spruce and lodgepole pine seed orchards.

- A fertilizer trial, involving several levels of nitrogen and phosphorus, was initiated in 2002 in a 17-year-old lodgepole pine seedling seed orchard. After one season's application, results are significant and promising, with trees receiving the best treatment bearing almost twice the number of female flowers as controls.
- A gibberellin (growth regulating hormone GA 4/7) trial was initiated in 2000 in both white spruce and lodgepole pine. Results were promising in both orchards, and are continuing in 2003 in the pine orchard.
- A trial of Ferbam (Carbamate WDG) as a fungicidal control agent for spruce cone rust *(Chrysomyxa pirolata)* was conducted in 2001 and 2003; however rust levels in 2001 were too low to evaluate efficacy.
- Several methods of cone crop estimation are being evaluated in 2003.

In addition, HASOC continues to establish and maintain a wide range of genetic trials to evaluate adaptation and field performance of selected parents and their offspring.

Western Boreal Aspen Corporation (WBAC) is a cooperative of four Alberta companies, which conducts supportive research for its genetics programs, including breeding, testing and selection, as well as basic research into aspen silviculture.

Genetics-related research involves stand-alone studies to address current challenges:

- Flower induction studies using plant growth regulators such as paclobutrazol and 2-chloroethyltrimethyl ammonium chloride (CCC) provided excellent results; consequently WBAC was able to complete about half of the first generation breeding in 2003.
- Member companies, together with private nurseries, are developing effective mass clonal propagation systems, which rely on aspen's natural suckering ability. Some techniques, such as the 'rootling' and 'stacked styroblock' methods, show potential for large-scale operational clonal stock production.

Silviculture research addresses eight main focus areas through a variety of projects. Objectives are to:

1. Develop a growing regime to produce planting stock with good survival and rapid early growth;
2. Develop methods (other than fencing) to minimize browse damage by ungulates;
3. Achieve successful deployment of improved materials in green area non-intensive plantations;
4. Identify the optimum physical environment and necessary site preparation for maximum growth of planted stock;
5. Develop silvicultural tools to control competing vegetation in aspen or poplar plantations;
6. Understand pest and disease issues affecting aspen, identify methods to identify them and develop coping mechanisms;
7. Define optimal nutrient regimes for aspen and poplar culture;
8. Determine optimal mixed-wood plantation silviculture regimes.

Alberta-Pacific Forest Industries Inc.

Al-Pac's research program involves a number of projects in cooperation with other partners including forestry, oil and gas, the Provincial Government, Agriculture Canada, University of Alberta, UBC, CFS and NSERC.

Research topics include:

- Understanding disease resistance in hybrid poplars to *Septoria*;
- Wood quality screening – 5- and 10-year evaluation (2003);
- Production and early establishment techniques for poplars and aspens;
- Silvicultural regimes;
- Operational fertilizer for mid-rotation plantations;
- Initial adaptive screening, genotype x environment interaction, and density trials;
- Mass propagation development for hybrid aspens;
- Development of a risk assessment model for introduction of hybrid and exotic aspens and poplars in northern and central Alberta;
- Effects of elevated CO_2 on early performance, and growth and allocation of resources in hybrid poplars and aspen;
- Potential for enhanced early selection in aspens through assessment of gas exchange parameters; and
- Assessing the potential for enhanced early selection in poplars through DNA marker analysis.